Enactivism: Utopian & Scientific

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> Context • Our target article concerns the direction and growth of enactivism, a framework portrayed as a revolutionary shift in understanding cognition. While enactivism continues to be a lively position, it is unclear how its contributions relate to the cognitive sciences. Despite some empirical successes, enactivism remains somewhat insulated as a theoretical position and as a research program. **> Problem** • There exists a discrepancy between enactivist aims and delivery. The basis of this problem, we argue, is that the overall objective of enactive theorising is not clear, which has led to diverging strategies for implementation and integration with the cognitive sciences. **> Method** • We review contributions from different strains of enactivism – autopoietic, sensorimotor and radical – and their research goals, both tacit and explicit. We show that enactivism is productively understood as two projects we term utopian enactivism and scientific enactivism. Utopian enactivism aims to develop a philosophically defensible lens through which cognitive science is to be viewed. Scientific enactivism intervenes in scientific practice by contributing to the implementation of enactive ideas. **> Results** • Once disentangled, the utopian and scientific projects have important but independent tasks. Utopian enactivism is useful for building a coherent and defensible enactive philosophy of nature, while scientific enactivism is free to draw upon and contribute to non-enactive approaches in the cognitive sciences. **> Implications** • We aim to motivate discussions that will enhance enactivism's progress, and our reappraisal also offers a clear and explicit roadmap for renewing advances in enactivist philosophy and cognitive science. **> Constructivist content** • We directly engage with the work of Humberto Maturana and Francisco Varela to advance their project. **> Key words** • **Enactivism, explanation, framework, paradigm, philosophy of nature, research program, Humberto Maturana, Francisco Varela**.

Introduction

« 1 » Since the beginnings of the movement, enactivists have claimed to be the heralds and architects of a revolution in cognitive science. As proponents of a prospective paradigm shift, enactivists have sought to build a cohesive framework for studying cognition that stands in opposition to mainstream cognitive science. However, enactivism is a house divided. There are now a number of diverging enactive frameworks, each differing in both their content and view of contemporary cognitive science. These have been drawn up into three different camps (Ward, Silverman & Villalobos 2017): *autopoietic enactivism*, *sensorimotor enactivism*, and *radical enactivism*. The autopoietic branch is associated with the foundational work of Humberto Maturana and Francisco Varela (1980) and Varela, Evan Thompson, and Eleanor Rosch (1991), sensorimotor enactivism with the work of Kevin O'Regan and Alva Noë (2001) and Noë (2004), and radical enactivism with the work of Daniel Hutto and Erik Myin (2013, 2017).

« 2 » We are not especially concerned with challenging, reinforcing, or eliminating these boundaries between the purported enactivist camps. Our contention, in this target article, is that this tripartite picture does not capture a deeper distinction at play within enactivism. We argue that there is a more fundamental divergence, consisting of separate enactivist projects working towards their own distinct ends. These we label *utopian enactivism* and *scientific enactivism*.

« 3 » What do we mean by utopian and scientific?[1] In brief, the utopian project is primarily concerned with building a philosophically cohesive enactivism. Utopian enactivism creates and promotes concepts that fit with enactivist beliefs about the organisation of life and mind, developing a broad worldview rather than a scientific research program. In other words, utopian enactivism is concerned with the development and defence of a uniquely enactivist *philosophy of nature* (Gallagher 2017, 2018b; Meyer & Brancazio 2022).[2] We call this project utopian, not because such a project is difficult or impossible, but because making an immediate difference to cognitive science *in practice is not its priority*. The import of such an account for science is taken to follow from the well-fortified conceptual base enactivism will build. A guiding axiom for the utopian approach is that the more philosophically defensible an account, the more success it will have in explaining phenomena, and thus contributions to the enactive philosophy of nature are seen as contributions to future scientific progress.

« 4 » Scientific enactivism, by contrast, is primarily concerned with building the conceptual machinery for enactivism chiefly in service to the more proximal needs of scientific research. This approach is less concerned with building an unblemished philosophical account, acting instead as a wing of

1| We borrow our title and these labels from Friedrich Engels's (1970) booklet *Socialism: Utopian and Scientific*.

2| Though this discussion focuses on enactivism, other frameworks within cognitive science might also be understood in terms of utopian and scientific projects. We thank an anonymous reviewer for pushing us to clarify this point.

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the broader interdisciplinary project of collaborative cognitive science.

« 5 » Our objective is not to proselytise for either project; both have something to offer, and both have limitations. However, we take as a basic commitment that making progress on our understanding of cognition necessarily extends beyond theoretical disputes and into the empirical domain. For enactivism, making progress may require having a hard look at the division between the utopian and scientific projects in order to determine where enactivists would be best served going next.

« 6 » The article will proceed as follows. In the next section, we explain the utopian and scientific projects and their goals in detail, and evaluate work within the branches of enactivism in relation to the utopian and scientific projects. The subsequent section evaluates these projects, first discussing the commitments that have driven the development of utopian enactivism, and then surveying the progress of scientific enactivism. The final section provides a conclusion.

Utopian or scientific

« 7 » Utopian enactivism is primarily directed towards the intra-philosophical task of constructing a theoretical, philosophically defensible enactivism. It is also strongly associated with the development of an enactive philosophy of nature (Gallagher 2017, 2018b; Meyer & Brancazio 2022). A philosophy of nature, in brief, is an overarching worldview that brings into relief the commitments and assumptions through which we can describe and re-describe scientific findings, and thereby construct a cohesive ontology of the natural world (Godfrey-Smith 2001). While it may at times structure the commitments of scientists in such a way as to influence scientific practice, it does not need to. Its primary goals are cohesion and philosophical robustness.

« 8 » Scientific enactivism takes as its most proximal goal an immediate, specific intervention into scientific practice such that enactivist concepts are put to work. This can mean that specific concepts or theories may be tested in isolation from their worldview using the methods, means, or language of conflicting frameworks in contemporary cognitive science. In order for research to count as scientific enactivism, it must meet one of the following requirements:

a it must involve empirical work, or
b it must include a clear and feasible roadmap for immediate and direct integration with current empirical research in the cognitive sciences.

« 9 » Our distinction rests on the diverse ways that enactivist research is pursued, yet also how these efforts converge around several core themes or objectives. We take for granted the broad commitments of enactivism's branches as outlined by Dave Ward, David Silverman and Mario Villalobos (2017):

> "Since TEM's [*The Embodied Mind*, Varela, Thompson & Rosch (1991)] publication there have been at least three semi-distinct currents of enactivist theorising. First, what is sometimes called autopoietic enactivism, which emphasises TEM's project of grounding cognition in the biodynamics of living systems; second, sensorimotor enactivism, which focuses on analysing the structure, content and character of perceptual experience in terms of the relationships between sensation and embodied activity; third, radical enactivism, which focuses on the case for rejecting representationalist explanations of cognitive capacities in favour of explanatory strategies emphasising patterns of embodied interaction."

« 10 » This gives us an initial lay of the land.[3] We identify a set of aims that span these branches: integration of phenomenology, investigation of the organising principles of cognition and life, investigating patterns of perception-action, expanding the explanatory reach of organising principles, and entrenching enactivism against criticism. In this section, we provide examples of contributions in these areas in terms of where they fit into the utopian and scientific projects to demonstrate that works across all branches implicitly fall in line with either the utopian or scientific project.

3 | We will include neither the branch of ecological enactivism (Rietveld & Kiverstein 2014) nor the work of Tony Chemero (2009), except in passing, due to their connection with the robust scientific research program of ecological psychology. We leave it an open question whether various works in ecological enactivism are contributing to scientific or utopian projects of their own.

Integration of phenomenology

« 11 » Both autopoietic and sensorimotor enactivism contain currents of thought that treat the integration of phenomenology into cognitive science as a deeply important part of the enactive project. In Thompson's (2007) key work in autopoietic enactivism, *Mind in Life*, he predicts that cognitive science will not be able to fully grapple with its subject matter until questions of subjective experience are integrated deeply into cognitive-science research in general. The integration of phenomenology is not merely desirable in Thompson's view, but quite necessary, since –

> "once science turns its attention to subjectivity and consciousness […] then *it cannot do without phenomenology*, which thus needs to be recognised and cultivated as an indispensable partner to the experimental sciences of mind and life." (ibid: 14, emphasis added)

Further, this integration will require the theoretical resources of autopoietic enactivism:

> "Subjectivity and consciousness have to be explicated in relation to the autonomy and intentionality of life, in a full sense of 'life' that encompasses […] the organisms, one's subjectively lived body, and the life-world." (ibid: 15)

« 12 » Proponents of sensorimotor enactivism such as Noë (2012) have also emphasised the centrality of *presence* as something to be explained by cognitive science. By presence, Noë means the appearance of objects in our direct perceptual experience of our environment. Sensorimotor enactivism requires that this phenomenon be investigated in a manner that "avoid[s] the pitfalls of denying the holistic character of consciousness, eliminating persons in favor of the brain or other sub-personal substitutes, and attempting to think of presence as a matter of representation" (Noë 2021: 958), instead seeking to explain presence in terms of how perceivers enact their environment through their engagement with it. The sensorimotor approach is consequently adamant that foregrounding phenomenal experience is important for a healthy cognitive science.

« 13 » Both Thompson's (2007) and Noë's (2012, 2021) efforts here provide ex-

amples of enactivists identifying perceived gaps in the study of cognition and proposing radical, overarching theoretical adjustments to make our sciences more complete. That is, they contribute to building the enactive philosophy of nature in opposition to a received view or framework, and thus serve as examples of the utopian project of enactivism. A key aim in these and other similar works is to indicate possible theoretical gaps that should be resolved in an ideal cognitive science, but they do not involve or propose empirical work.

« 14 » However, we do find specific proposals and empirical work incorporating phenomenology into contemporary cognitive sciences in neurophenomenology. Beginning with Varela's (1996) proposal for a new approach to studying consciousness, neurophenomenological work aims to develop new experimental paradigms that bridge enactivism, psychology, and neuroscience (Thompson, Lutz & Cosmelli 2005; Gallagher & Sørensen 2006). Neurophenomenology studies the phenomenological observations of trained observers in tandem with data gathered on the neural correlates of these observations. In doing so, the aim is to "bridge the gap" between subjectivity and third-personal scientific observations in a way that rigorously captures relationships between the structure of consciousness and the dynamics of brain activity. Despite some concerns about its ability to make progress in the cognitive sciences due, for instance, to the lack of suitable complementary cognitive models (Berkovich-Ohana et al. 2020), this empirically oriented neurophenomenological work belongs to the scientific enactivist project.

Investigating organising principles of cognition and life

« 15 » One of the main ways in which enactivists have sought to rethink cognition is by grounding it in principles of biological organisation. Autopoietic enactivism has as its bedrock the claim that what defines and distinguishes living things is their autopoietic organisation. Autopoiesis (Maturana & Varela 1980) describes the processes of self-production and self-maintenance undertaken by systems that actively channel energy into sustaining their own organisation and components. Such a system constitutes an autonomous unity, a network of metabolic and boundary-maintaining processes that are mutually dependent on one another, and in being so are distinguished from their surrounding environment. The most fundamental example is the biological cell, a clear case of an autonomous unity that "continuously produces itself as a spatially bounded system, distinct from its medium and milieu" (Thompson 2007: 92).

« 16 » The principle of autopoiesis was explicitly intended as a testable scientific posit. Maturana (2002) makes this clear by arguing that autopoietic theory provides an explanation of what it is for something to be alive by pointing to the observable molecular processes that occur in cells as preliminary and steadily expanding evidence that autopoiesis is indeed an explanatory notion. Autopoiesis has been operationalised and tested, for instance, in models of solo bacteria (Egbert & Di Paolo 2009) and structural coupling for an autopoietic unity in the simulated physics of the Game of Life (Beer 2015, 2020). These works thus exemplify scientific enactivism.

Investigating patterns of perception and action

« 17 » Another task undertaken by enactivists has been the experimental investigation of the kinds of sensorimotor patterns of engagement and learning that they propose have been neglected as genuinely cognitive by mainstream approaches. These are taken as examples of areas of cognitive science where an embodied, dynamical approach provides a novel and productive lens onto old problems. Varela and Maturana's early rejection of information-processing-based thinking about cognition and their alternative structural coupling conception, coupled later with significant developments of applicable models in dynamical systems theory (i.e., Haken, Kelso & Bunz 1985; Kelso 1995) has formed the nucleus of an enactive cognitive science of perception and behaviour. Enactive ideas have since percolated through into some spheres of experimental psychology, usually as part of the larger milieu of extended and embodied accounts of cognition.

« 18 » Early sensorimotor enactivist work is full of proposals for how its approach can translate into concrete, testable claims and has seen direct uptake in empirical work. O'Regan and Noë's (2001) initial formulation of the sensorimotor enactive approach, for example, proposes a variety of alternative empirical possibilities for investigating visual experience as involving sensorimotor contingencies. Proposals for how to study and test the phenomena that mainstream psychology has struggled to understand with its own framework, such as change blindness (Rensink, O'Regan & Clark 1997) and colour perception (Philipona & O'Regan 2006; Bompas & O'Regan 2006), have grown out of the sensorimotor approach, and there has been an ongoing productive relationship in some corners of enactive cognitive science (i.e., Froese & Ortiz-Garin 2020; Witzel et al. 2022). These contributions fall under the umbrella of scientific enactivism.

Expanding the explanatory reach of organising principles

« 19 » A common counterpart to the foregoing aims is the attempt to link together an expanded enactive framework at different scales of cognition. This task seeks to expand enactivism's reach from just the autonomous organisation of cells and sensorimotor contingencies and thereby ensure it is not exclusively an account of cell cognition or human perception. The method employed is to utilise enactive principles in understanding cognition at multiple scales of complexity, demonstrating that these principles can explain cognition more broadly.

« 20 » Most notably, accounts originating from within autopoietic enactivism have used the notion of autonomy in order to expand enactivism to a fuller range of cognitive phenomena. Autonomy here is a generic kind of organisation systems can instantiate, of which autopoiesis is the most basic (and founding) example (Barandiaran 2017). Autonomy is characterised as –

> "a type of process organization that is constituted as a network of interdependent processes, where the behaviour of the whole emerges from the interaction dynamics of its component parts in a self-organized […] manner." (Barandiaran 2017: 411)

The boundaries of the system are generated by the network itself in the ongoing participation of these processes in the system's

production and maintenance, establishing it as operationally closed (Maturana 1981). Such systems are thereby self-producing and self-maintaining, though their conditions of viability can vary greatly depending on the specific nature of that network. As such, autonomy can be applied to explain a greater range of adaptive behaviour in cognitive systems at different scales of complexity. For example, proponents of autopoietic enactivism locate three connected dimensions of embodiment that instantiate principles and/or concepts based in autonomous organisation: organismic organisation (described above), sensorimotor coupling of organism and environment, and intersubjective interaction (Thompson & Varela 2001). More recently, a fourth dimension of linguistic embodiment has also been proposed (Di Paolo, Cuffari & De Jaegher 2018).

« 21 » Enactivists have also articulated linkages to human experiential and psychological phenomena. Thompson (2007) has proposed that the more elaborate features of cognition, such as selfhood and conscious experience, emerge from basic autopoietic autonomy (self-maintenance and self-production). Sense-making, which is argued to stem from the normativity inherent for basic organismic self-maintenance (e.g., metabolic needs and harm avoidance), and which establishes an organism's "evaluative interaction with its environment" (de Haan 2020: 7), has been argued to give rise to affective valence for more complex organisms, such as humans, and has been used as the basis for theories about complex psychological phenomena in interaction (De Jaegher & Di Paolo 2007). Partnered with these concepts is a revised concept of autonomous agency: an agent is "an autonomous system capable of adaptively regulating its coupling with the environment according to the norms established by its own viability conditions" (Di Paolo, Buhrmann & Barandiaran 2017: 127). This concept of agency is likewise expanded beyond the organisational and sensorimotor realms into intersubjective agency (*ibid*) and linguistic agency (Di Paolo, Cuffari & De Jaegher 2018). The principle of autonomous organisation has also been used as grounding for speculative theories concerning the organisational basis of language acquisition, cultural norms, and human institutions (*ibid*).

« 22 » The full inventory of enactive offerings is even more expansive: enactive accounts of neuroscience (Fuchs 2011; Froese 2015), psychiatry (de Haan 2020), artificial intelligence (Froese & Ziemke 2009), sociopolitical conflict (Fourlas & Cuffari 2022), ethics (Di Paolo & De Jaegher 2022), health and disease (Svenaeus 2022), and emotion (Colombetti 2014) have all been developed (among many others too numerous to list), all emphasising some degree of continuity between Maturana and Varela's work on autonomous agency on the one hand, and human psychology, culture, and cognitive capacities on the other.

« 23 » Where do these expansion efforts fall in terms of the utopian and scientific projects? While the explanatory value of the foundational example of autopoiesis is, as we have discussed, well tested, the bulk of this work offering proposals for how to expand the explanatory reach of enactivism from the organisation of cells or collections thereof to perception and action, emotions, ethical decision-making, and so on, has not involved empirical implementation. What we propose is that many such contributions, given that they have not yielded proposals for empirical research or immediate integration with the cognitive sciences, have instead served to flesh out an overarching ontology of cognition and biology that can make sense of cellular life at the one end and human psychology, society and culture at the other. This expansion of enactivism is more akin to a 16th-century mechanist attempting to formulate machine-metaphorical descriptions of the natural phenomena they encounter in order to fit them into their new worldview (Dijksterhuis 1986). With these points in mind, the majority of works expanding the reach of enactivist principles are best described as contributions to the project of utopian enactivism: they expand the enactive philosophy of nature.

« 24 » A noteworthy exception is De Jaeger's theory of participatory sense-making (De Jaeger & Di Paolo 2007). Within the domain of social cognition, in particular, the notion of participatory sense-making has been put to the test as a descriptive and explanatory tool for understanding coordinated behaviour as instantiating autonomous organisation. The perceptual-crossing experimental paradigm, for example, was elaborated in line with Hanne De Jaegher and Ezequiel Di Paolo's (2007) proposals about sense-making in social cognition (Di Paolo, Rohde & Iizuka 2008; Auvray & Rohde 2009; Froese & Di Paolo 2010). Work such as this, therefore, belongs to the scientific project.

Entrenching enactivism against criticism

« 25 » This final objective is strongly associated with the "radical enactivist" account. Instead of a fully implemented alternative version of enactivism, radically enactive cognition (REC) is perhaps better thought of as a critical stance intended to, in its own words, "cleanse, purify, strengthen and unify a whole set of existing anti-representational offerings" (Hutto & Myin 2017: 56). This is what is meant by radical: it aims to "radicalize existing versions of enactivism through a process of philosophical clarification" (Hutto 2017: 379). Radical enactivism thus endorses many of the core beliefs associated with autopoietic and sensorimotor enactivism, sounding the alarm when their language or theories appear to align with those of computationalism. The way radical enactivists talk about this process is linked to transformation of the target accounts; once it has been "RECtified," said account will possess greater explanatory rigour than before by virtue of its philosophical defensibility.

« 26 » An illustrative example comes from Hutto (2019), who targets Shaun Gallagher's (2017) sketch of how mathematical reasoning, a kind of cognition traditionally thought to be the epitome of symbol-manipulating, representation-hungry cognition, could be performed on the enactive account. The core of the critique pursued by Hutto's (2019) project of RECtification revolves around Gallagher's (2017) pluralistic incorporation of non-enactive accounts. George Lakoff and Rafael Núñez's (2000) account of mathematics as an embodied phenomenon permits that neural mechanisms that perform inferences as part of mathematical reasoning could underpin the phenomenon. This and other attempts at pluralistic integration of other accounts are bound to fail, since "this theoretical package deal does not sit well with Gallagher's brand of enactivism" (Hutto 2019: 831).

« 27 » The alternative, positive account offered by Hutto (2019) does not take the form of any specific proposal about mathematical reasoning or how a RECtified account might be put into practice, but instead an exhortation to hew to enactivist commitments:

> "Subtract any residual commitment to mental representation, information-processing stories, and neuro-fetishism. Add, in place of these items, a more Andersonian account of neural reuse – one that focuses on the pluripotent, protean brains and which places the greater weight on the contributions of socio-cultural practices in establishing mathematical content and competencies […] Subtract any residual constructivism, anti-realism, and idealistic elements from the account. Finally, subtract any lingering psychologism about mathematics and its content." (Hutto 2019: 835)

« 28 » However, Hutto (2019) provides no roadmap for implementation. While radical enactivism's preemptive defences are presented as important to scientific progress for enactivism, their genuine contribution is in shoring up an enactive philosophy of nature. These efforts thus belong to utopian enactivism.

« 29 » Such defences and exhortations are also found elsewhere in enactivism, albeit directed against its long-running philosophical sparring partner, cognitivism. A broad prescriptive vision for cognitive science has emerged from the enactive tradition, an approach that has its roots in its foundational text (Varela, Thompson & Rosch 1991). There, the authors state that a representationalist "unreflective stance" is "one of the greatest dangers facing the field of cognitive science; it limits the range of theories and ideas and so prevents a broader vision and future for the field" (ibid: 133f). Even more strongly stated, they claim that "scientific progress in understanding cognition will not be forthcoming unless we start from a different basis from the idea of a pregiven world that exists 'out there' and is internally recovered in a representation" (ibid: 150). We read much of enactivist research since this time as continuing to fill out this broader vision for the field and conceptually clarifying how we can understand a world that is not "pregiven," rather than creating an alternative cognitive science. Such contributions also fall under the utopian project.

Divergent goals

« 30 » In this section we will elaborate on how exactly utopian and scientific enactivists are respectively going about their projects, clarifying their diverging aims. Commitments to different methods, suited to their own particular objectives, have resulted in notable differences between utopian and scientific enactivist offerings regarding how progress for enactivism should be pursued. Consequently, scientific enactivism may at times violate the norms of utopian enactivism, and vice versa. In this section we point to some of the challenges encountered by researchers within each area in seeking to meet their objectives.

Utopian enactivism

« 31 » What we have here called utopian enactivism is geared towards building a cohesive philosophy of nature rather than a scientific paradigm (Gallagher 2017, 2018b; Meyer & Brancazio 2022). A philosophy of nature takes developments in science and philosophy and weaves them together into an overarching worldview. It is broader than a scientific paradigm since, unlike a paradigm, it is not concerned with the precise means and methods of a given research program (Kuhn 1962). Work within utopian enactivism prioritises articulating a cohesive version of the non-representational, holism-inclined perspective on cognition adopted by enactivists and honing its commitments and reach. Utopian enactivism is thereby at somewhat of a remove from scientific practice. The efforts of researchers contributing to utopian enactivism are not directed towards setting up and testing out specific research questions, but with defending and expanding enactivism as a coherent system of theories, principles, and concepts.

« 32 » Below we discuss some themes of discussion found in utopian enactivism. We point to areas where these bring utopian enactivism into conflict with its own core goal of advancing an enactive philosophy of nature, and also with the goals of scientific enactivism.

Proclamations & proscriptions

« 33 » There has long been a tendency within utopian enactivism to make very strong claims about what scientists *ought to be doing.* The most ubiquitous of these involve arguments about the insufficiencies or inconsistencies (philosophical or otherwise) in the cognitivist framework. Many landmark works in enactivism begin with or contain developed critiques of representationalism (Varela, Thompson & Rosch 1991; Thompson 2007; Di Paolo, Buhrmann & Barandiaran 2017), characterised as the view that cognition is chiefly performed via the manipulation of contentful, internally located symbols. The most sustained critique of this sort comes from Hutto and Myin (2013, 2017), who argue that representationalism faces what they call the "hard problem of content" – in brief, that representationalism is in defiance of naturalism. Though representationalism of this type is but one of many examples of how representations have been used in the sciences (Shea 2018; Baker, Lansdell & Kording 2022), this view of representations and their explanatory role in cognitive science – as incompatible with enactive commitments – is used (Varela, Thompson & Rosch 1991; Thompson 2007; Hutto & Myin 2013, 2017; Di Paolo, Buhrmann & Barandiaran 2017) to advocate for an enactivist framework for cognitive science. Such a framework aims to achieve "enactive escape velocity" (Di Paolo, Buhrmann & Barandiaran 2017: 11) from representationalism, rather than integrate with existing frameworks that use representational language, and must instead replace such frameworks.

« 34 » One challenge for utopian enactivism that emerges as a consequence of this treatment of cognitive science as a monolithic venture guided by a set of overarching philosophical commitments is a misconstrual of cognitive science in practice, which is by definition not such a monolith. Once we zoom in on a given discipline or research program within one of the multiple sciences of cognition, how exactly enactivism changes things becomes a more nuanced question that must attend to the needs of researchers in those fields. It should be uncontroversial that the lab settings of, for example, psychologists and neuroscientists differ from one another in methodologies, equip-

ment, explanatory goals, assumptions and background beliefs, and so on. Linguistics, artificial intelligence, computer science, anthropology, and related areas of biology are, similarly, very different fields. While Varela, Thompson & Rosch (1991), for instance, acknowledge the diversity of cognitive science practices, they nevertheless place the entire field on an ideological continuum between the poles of cognitivism and enactivism, attributing a set of undesirable commitments to the former. Likewise, Thompson (2007), as we have already noted, treats cognitive science collectively as the target of his critiques of the explanatory gap left by subjectivity.

« 35 » The important question of how exactly enactivist beliefs could become foundational for the cognitive sciences is only sidestepped when this diversity of research programs is replaced with an illusory image of a unified, monolithic Cognitive Science. However, proposals demonstrating increased explanatory purchase and breadth with the inclusion of enactivist ideas for distinct phenomena do seem to have an impact. A contrast can be drawn here between general calls for phenomenology to be integrated into cognitive science and, for example, Gallagher's interactionist account for social cognition. Gallagher's interactionist account integrates phenomenological insights in specific areas of research within psychology and neuroscience and provides novel interpretations of experimental results in dialogue with scientists (e.g., Tsakiris, Schütz-Bosbach & Gallagher 2007; Gallagher et al. 2015), which have since been themselves implemented in new experimental designs.

« 36 » Further, because the utopian project is not aiming for immediate integration with other frameworks for understanding cognition, at times, it uses its own internal language: "extensive" (Hutto, Kirchhoff & Myin 2014) and "loopy" (Hutto & Myin 2013: 6). Other core enactivist terminology like *self-organisation* and *emergence* instead originated in close observance of the origins and meaning of those terms in synergetics and coordination dynamics research (Varela, Thompson and Rosch 1991, Thompson 2007). However, in enactive usage, a broader interpretation of these terms is employed in order to establish conceptual linkages. For instance, enactive proposals on the emergence of the self (MacKenzie 2010), identity (Kyselo 2014), and the human mind (Fuchs 2011) all employ emergence in a broader and more liberal sense. Similarly, discussions on the self-organisation of human relationships (Kyselo & Tschacher 2014), emotions (Colombetti 2014), conscious experiences (Thompson 2007), and language (Di Paolo, De Jaegher and Cuffari 2018) make more speculative or analogical reference to self-organisation when conceiving its role in producing these phenomena. These shifting meanings across context, while useful for the utopian project, create challenges for the integration of such accounts into those scientific research programs already using similar terminology. Scott Kelso, one of the pioneers of the coordination dynamics approach, has, for instance, recently lamented that self-organisation has come to be "used as a kind of vague, throwaway term that stands for spontaneous order and emergence in complex systems" (Kelso 2021: 2) quite distinct from its original employment.

« 37 » Wide-ranging proclamations and proscriptions leave it unclear what enactivism has to offer practitioners in particular cognitive sciences in return for abandoning their successful research. Hutto and Myin (2013, 2017), for example, do not make a case for why philosophical vulnerabilities (for example, sensorimotor enactivists retaining talk of representations) are a problem for cognitive science in practice, and further, why they should matter to enactivists engaged in scientific practice. One way to make such a case would be to point to difficulties faced by allegedly philosophically suspect accounts. If science has had trouble making use of, for instance, sensorimotor enactivism as a consequence of that branch's commitments to representationalism, then radical enactivism could well be targeting a genuine roadblock for enactive cognitive science. Yet, sensorimotor enactivism's proposals have, as we noted earlier, been used as a basis for empirical research.

« 38 » Ultimately, by approaching cognitive science with demands for change that lack the necessary blueprints for implementation, the utopian perspective has treated enactivism as though it (to borrow a phrase) "is the expression of absolute truth, reason and justice, and has only to be discovered to conquer all the world by virtue of its own power" (Engels 1970). For those scientists whose work is fine-grained and specialised towards precise explanatory tasks, many unprocessed enactive beliefs are too coarse to do anything with.

« 39 » The trouble here is not that enactivists are developing these kinds of ideal visions for cognitive science. The problem is characterised best by Chemero (2009) in his discussion of *Hegelian arguments*, i.e., critiques of a given scientific research program on the grounds that its guiding theoretical framework is philosophically flawed (and which, Chemero argues, tend to be ineffective at influencing scientific practice), pointing to Hubert Dreyfus' (1972) critiques of cognitivism and Jerry Fodor & Zenon Pylyshyn's (1988) rebuttal of connectionism (among others).[4] As Chemero observes, in the course of such debates philosophers have defeated their foe in the realm of ideas only to find that science is heedless to their critiques. As long as a framework continues to generate questions that researchers can answer, it will continue to be the predominant paradigm in a research community, whether or not there might be a few cracks in the foundation (Kuhn 1962).

Virtuous pagans

« 40 » Enactivists are well aware of enactivism's relative paucity of uptake in the sciences. With a small pool of empirical research of their own to draw from relative to mainstream approaches, enactivists reference related research programs or scientific work as evidence of a long-standing program of research. For example, while enactivism has always drawn insights from phenomenology (Varela, Thompson & Rosch 1991), enactivists such as Gallagher (2018a: 43) also point to the "enactivist elements in phenomenology," finding support in the phenomenological works of Husserl, Heidegger, and Merleau-Ponty. Much as philosophers of the Middle Ages interpreted their

4| Chemero (2009: 24) characterises Hegelian arguments as those "based on little or no empirical evidence, to the conclusion that some scientific approach […] will fail." The name derives from Hegel's rejection of astronomical observations of a planet between Mars and Jupiter (later identified as the asteroid Ceres) due to his view that its existence was logically impossible.

classical forebears as touching on ineffable truths ahead of their time, enactivists similarly find fellow enactivists "avant la lettre" (Di Paolo, Buhrmann & Barandiaran 2017: 3).[5] These virtuous pagans of cognitive science are considered (ibid; Gallagher 2018a) to have been doing enactivism all along.

« 41 » A more science-based example of this comes from *The Embodied Mind*, where Varela, Thompson and Rosch (1991) are already aware of concerns about the practical applicability of enactivist beliefs and introduce Rodney Brooks's (1989) work on robots as an example of some of enactivism's tenets at work. Brooks's work ran against the grain of contemporaneous cognitive science, especially AI research, since researchers building models of cognition had assumed that highly centralised processing was necessary for intelligent behaviour. The success of Brooks's robots, which relied more on distributed processing without abstracting to representations, was powerful evidence for a new understanding of how both AI and natural organisms perform intelligent, perceptually guided behaviour.

« 42 » This is a questionable move, given that Brooks was not doing enactivism here by any measure. On the contrary, his stated views on the nature of minds frequently run directly against what enactivists consider core, important beliefs for proper cognitive science to proceed. Specifically, Brooks's position was not strictly non- or anti-representationalist about cognition, nor was Brooks committed to an extensively constituted notion of minds – or even interested in explaining human or animal cognition (Brooks 1991). The critique in Brooks's work, and the revised, positive account it presents is a refinement of mainstream cognitive science, not a rejection of it. That Brooks was successful in moving away from some central cognitivist tenets does not clearly score a point for enactivism. Rather, it shows that contemporary cognitive science has the capacity to incorporate some useful enactive proposals as needed.

« 43 » The bigger issue here is thus not limited to Varela, Thompson and Rosch's (1991: 208) claim that Brook's research program is "akin" to enactivism, but that this way of arguing for retroactive enactivist tenets shows that a complete rehaul of cognitive science is unnecessary. If one can do work that, by enactivist standards, is viewed as a success, and which elicits a broader uptake than enactivist work and nudges the mainstream in a desirable direction (à la Brooks), the motivation for adopting enactivism's full suite of commitments is undermined. In a similar vein, we can ask how phenomenology could be integrated to improve, to pick an area of significant recent interest, psychology studies of the ongoing effects of Covid-19 isolation on well-being. Experimental psychology already implements phenomenological methods sans enactivism, i.e., phenomenological studies of the wellbeing of medical staff during the Covid-19 pandemic (Karimi et al. 2020; Arcadi et al. 2021; Afshan et al. 2022). If already capable of such incorporation without abandoning other important explanatory resources disagreeable to enactivists, it is not clear why experimental psychology would need to adopt the full enactivist philosophy of nature over selecting piecemeal resources and concepts as needed to achieve explanatory success.

« 44 » Utopian critiques of cognitive science on the basis of imperfect philosophical underpinnings are thus met with several challenges. Proclamations and proscriptions overemphasise the importance of implementing an entire philosophy of nature. Additionally, in retroactively endorsing theoretical and scientific interventions, enactivism demonstrates that there is no pressing need for full adoption of its tenets by pointing to the past successes of its virtuous pagans. Building a philosophy of nature is an important task, but it is a different task from integration with contemporary cognitive science, which necessitates sharing methodologies, languages, measures, and models, even if the aim is to change them. The point is best summarised by Thompson:

> "In my estimation, this way of proceeding – by analysing and criticising other theories instead of starting from basic theoretical and empirical issues and using them to motivate the careful construction of a positive theoretical framework with testable models – is not a good way to proceed in cognitive science." (Thompson 2018: §4)

« 45 » This is not to give the impression that all utopian work is critical rather than positively oriented. Here again we point to the important tasks of building a philosophy of nature. As Peter Godfrey-Smith (2014) has described it, building a philosophy of nature involves re-describing the existing work of empirical research programs in order not only to build a broader understanding of the phenomena under study within that program, but to integrate that understanding with a more comprehensive and extensive picture of the natural world. This might involve using resources from across the sciences, incorporating preferred ontological assumptions or beliefs, using certain epistemic framings, and so on. Gallagher builds on this in explaining why we ought to think of enactivism as a philosophy of nature, as the particular sciences "don't always consider how the dynamical relations among those pieces work, and don't always have the vocabulary to address those relations" (Gallagher 2017: 22). In Meyer & Brancazio (2022), we argue that a philosophy of nature thus also underpins scientific progress by providing an impetus for scientific advancement, sketches for integration, and new vocabularies that cut across various disciplines. Such theory-building may occur long before possibilities exist for full implementation in the sciences.

Scientific enactivism

« 46 » The aim of scientific enactivism is to find ways to incorporate enactivist principles into the cognitive sciences and involves empirical work or specific, achievable proposals for such work. Given the diversity of the cognitive sciences and phenomena to be studied, the project of scientific enactivism has advanced largely piecemeal, and only within a handful of areas. Despite this, there have been numerous successes in these areas, as well as the development of new technologies for conducting research (such as the "enactive torch," see Froese et al. 2012), showing the potential for further integrations and methodological developments. We will discuss here a representative sample of successful research in scientific enactivism.

5| For example, a brief summary connecting the work of Piaget with the work of Varela in their book *Sensorimotor Life* is entitled "Piaget, an enactivist?" (Di Paolo, Buhrmann & Barandiaran 2017: 83).

« 47 » Autonomous robotics and evolutionary modelling methodologies have both benefited from the incorporation of enactivist insights. Randall Beer's (1995) early work on hexapedal robots, for example, drew from autopoietic theory's idea of the structural coupling of organism and environment and put it into practice, producing insect-like robots able to navigate novel and uneven terrain adaptively while lacking any analogue to a central nervous system or processor. Simulations of perceptual crossing have been crucial for building and testing enactive accounts of social interaction dynamics (Di Paolo, Rohde & Iizuka 2008; Auvray, Lenay & Stewart 2009; Rohde 2010). More recently, Matthew Egbert and Xabier Barandiaran (2022) have developed a number of simulations to incorporate and test enactivist ideas involving sensorimotor contingencies and sensorimotor habit formation in robotics. Beer has also used computational models, such as the Game of Life, to conduct formal analyses of core enactive concepts such as autonomy, precariousness, structural coupling, and boundary maintenance in a sample universe (Beer 2015, 2020).

« 48 » Enactivism also makes an appearance in the work of Esther Thelen and Linda Smith and collaborators (Thelen et al. 2001; Smith & Thelen 2003), whose work in developmental psychology provided a series of dynamical systems-based explanations of phenomena in infant development. Previously only poorly or partially understood features of infant sensorimotor development such as perseverative reaching were described not in terms of brain development, but in terms of embodied engagement with an environment giving rise to new system-wide dynamics in the infant's body, best modelled as trajectories through the state-space of dynamical systems and dynamic field models.

« 49 » As mentioned above, neurophenomenology has proven to be a rich point of integration between the study of experience from the first-person perspective and the more removed approach of neuroscience. Phenomenological reports have been combined with studies of dynamic neural signatures to study experience during visual tasks (Lutz et al. 2002), and have been quantitatively analysed to understand experiences during the onset of sleep (Nielsen 2017). Neurophenomenological methods were utilised by a large interdisciplinary team in conducting an extensive empirical analysis of awe and wonder in simulated space travel (Gallagher et al. 2015). Neurophenomenological methods have also been used in understanding social interaction through an enactive lens (Froese & Fuchs 2012), and have also been coupled with some of the haptic technologies mentioned above that have been developed specifically for evaluating cognition as active and embodied rather than merely involving data generated from devices measuring neural activity.

« 50 » With all of this under its belt, what is holding scientific enactivism back from more widespread success in the cognitive sciences? We leave this an open question, but note two possible challenges. First, while enactivism has much to say regarding what cognitive science should and should not do, contributions "in the arena" of scientific enactivism appear significantly outnumbered by contributions to the utopian project. Second, utopian contributions toward building an ideal enactivist cognitive science do not provide much guidance in terms of integration with the cognitive sciences that exist. If a major theme of enactivist thought is that making use of the language, methods, or ideas from mainstream accounts threatens the philosophical integrity of enactivist efforts (i.e., Hutto 2019, also see Di Paolo, Buhrmann & Barandiaran 2017 on functionalism), this lack of guidance is perhaps not surprising. As discussed above, utopian enactivism does not tend to look favourably on the use of the language or resources of computational frameworks, given that they do not have a place in the enactive philosophy of nature. However, that computational language and resources are common currency within the cognitive sciences does not at all preclude the use of other, more enactivist-friendly contributions. Tom Froese's (2015) proposal for enactive neuroscience, for instance, suggests that developments in mainstream neuroscience have already begun to shift away from localisation and decomposition efforts, and towards a more embodied and distributed understanding of the brain, suggesting the possibility of a productive, overarching convergence of commitments between cognitive science and the broad strokes of enactivism.

Conclusion

« 51 » A final question to be raised here regards a potential merger. Why not combine utopian and scientific enactivism in some way to achieve the best of both applicability and philosophical defensibility? Is it possibly better to view contributions as existing along a spectrum rather than in terms of two distinct projects? Our response is that the goals of practical application and philosophical defensibility can be antagonistic to one another. As we have discussed, the project of utopian enactivism prioritises comprehensiveness over immediate application. This undermines scientific enactivism's goal of empirical implementation, which requires flexibility and, to some extent, compatibility with contemporary cognitive science. Moreover, the benefit of utopian intervention into scientific enactivism is doubtful: it should be clear by now that further philosophical sculpting of enactivist concepts is unlikely to translate into scientific progress for enactivism without more contributions to the project of scientific enactivism. Ultimately, utopianism is not fit for the same purpose as scientific enactivism, and attempts to merge into the same lane as scientific enactivism are bound to result in an occasional collision.

« 52 » An enactivism that does not respect the divergent aims of its constituent projects risks embodying the kind of enthusiastic yet ineffectual discourse lamented by Engels (1970) in a (very different) revolutionary context, where he observed the results of an overreliance on utopianism and subsequent neglect of the details of implementation. Beer has more recently pointed to philosophical debates within enactivism, saying that –

> "[i]t is only by debating theories rather than intuitions, by calculating consequences rather than speculating about them, that I believe scientific progress can be made. At their best, such work can supply a kind of skeleton upon which an understanding of more realistic biological systems can slowly be built. But at the very least, it allows us to rigorously concretize the terms of debate, providing anchors in a sea of words." (Beer 2019: 3)

Navigating these waters is made more manageable once we understand these debates as involving contributions to separate utopian

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and scientific enactivist projects. Distinguishing the utopian from the scientific clarifies some of the underlying parameters and expectations for implementation in these debates, and may perhaps inform considerations about how best to advance enactivist ideas overall.

« 53 » Our aim in developing this analysis has been to reappraise enactivism by its overarching aims and implementation strategies rather than by its conventional subdivisions. In doing so, we sought to ameliorate some of the confusion and friction that has hampered its progress. We hope that once understood as involving two distinct projects, enactivists can appreciate the achievements and successes of both utopian and scientific enactivism, and that both can pursue their projects in the ways that best meet their own differing goals.

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